

5. (Currently amended) ~~The model~~ A system of claim 3 ~~1~~, wherein ~~osteon-mechanical properties comprises~~ the viscoelastic property is selected from the group consisting of an angle-of-twist as a function of torque, osteon hydroxyapatite content, strain rate, and time.

6. (Currently amended) ~~The model~~ A system of claim 5, wherein the angle-of-twist as a function of torque is derived from tests conducted under monotonic or dynamic loading.

7. (Currently amended) ~~The model~~ A system of claim 5, wherein angle-of-twist as a function of torque at an approximately constant strain rate and approximately constant hydroxyapatite content is represented by a Ramgood-Osgood equation.

8. (Currently amended) ~~The model~~ A system of claim 7, wherein a higher hydroxyapatite content leads to a higher angle-of-twist as a function of torque.

9. (Currently amended) ~~The model~~ A system of claim 7, wherein a higher strain rate leads to a higher angle-of-twist as a function of torque.

10. (Currently amended) ~~The model~~ A system of claim 1, comprising the viscoelastic properties of ~~longitudinal~~ extinct and alternate osteons.

11. (Currently amended) ~~The model~~ A system of claim 10, further comprising a third hierarchical order comprising at least one third order component representing one or more collagen bundles, hydroxyapatite crystallites, mucopolysaccharides, or combinations thereof within one or more regions of the second order components, wherein the third order components are used to construct the second order components;

wherein the viscoelastic properties ~~comprises~~ comprise at least one parameter selected from the group consisting of ~~mechanical properties,~~ collagen content, mucopolysaccharide content, and hydroxyapatite content, ~~and collagen bundle orientation relative to osteon axis.~~

25. (Currently amended) The method of claim 24, wherein the ratio of collagen and mucopolysaccharides in a ~~longitudinal extinct~~ osteons of the selected bone as compared to an alternate osteon of the selected bone is less than 1[[,]] for a ~~longitudinal extinct~~ and alternate osteon with approximately equal hydroxyapatite contents.

26. (Currently amended) The method of claim ~~24~~ 31, wherein the viscoelastic property of the second order components is modified based on collagen-bundle ~~direction related to osteon axis is determined by~~ directions of the selected bone, the method further comprising the step of:
determining collagen-bundle directions of the samples using circularly polarizing light microscopy, confocal microscopy or X-ray diffraction of the samples.

27. (New) A system as in claim 1, wherein the viscoelastic properties of the second order components are assigned based on a plurality of experimental determinations.

28. (New) A system as in claim 10, wherein each subject bone is divided into a plurality of samples from corresponding locations of each subject bone;

one or more viscoelastic properties of at least one second order component of each sample is evaluated; and

the evaluations are aggregated to determine the viscoelastic properties of the second order components.

29. (New) A system as in claim 1, wherein the aggregated evaluations are collected in a database of viscoelastic properties for the subject bone of the specified type.

30. (New) A method of claim 17, wherein the viscoelastic properties of the second order components are assigned based on a plurality of experimental determinations.

31. (New) A method of claim 30, wherein the experimental determinations comprise the steps of:

- selecting a plurality of subject bones of a specified type;
- dividing each of the subject bones into a plurality of samples, wherein each sample corresponds to a location within the specified macroscopic region of each subject bone;
- evaluating one or more viscoelastic properties of at least one second order component of each sample; and
- aggregating the evaluations.

32. (New) A method of claim 31, wherein the experimental determination further comprises the steps of:

- repeating the experimental determination steps for subject bones of different types; and
- compiling a database of representative viscoelastic properties of each type of subject bone based on the aggregated evaluations.

33. (New) A method of producing a model of a bone comprising the steps of:

- a) specifying a first order macroscopic region of a selected bone;
- b) dividing the macroscopic region into a finite number of elements, each element representing a second order component comprising one or more alternate and extinct osteons;
- c) assigning a viscoelastic property to at least one second order component, wherein the viscoelastic property comprises at least one parameter selected from the group consisting of collagen content, mucopolysaccharide content, hydroxyapatite content, osteocyte content, osteoblast content, and content of porosity fluids; and
- d) determining a viscoelastic property of the first order macroscopic region of the selected bone based on the viscoelastic properties of the second order components.

34. (New) The method of claim 33, wherein the viscoelastic property of the second order components is modified based on collagen-bundle directions of the selected bone, the method further comprising the step of:

